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ABSTRACT

Investigated with 26 gifted seventh-grade girls was the influence of an experimental summer mathematics acceleration program on later mathematics course-taking behavior. Classes were designed to provide social stimulation through such methods as using a woman teacher and assistants for role models, informal structure, organization for small group and individualized instruction, stressing cooperative activities, and emphasizing ways in which mathematics could be used to solve social problems. Among conclusions after a 3-year follow-up were that the course-taking behavior of gifted girls can be modified by early intervention, and that career interest appears to be more difficult to influence. (IM)

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Changing Behaviors and Attitudes of Gifted Girls

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Changing Behaviors and Attitudes of Gifted Girls

Far fewer women than men pursue careers in mathematics or science. There has been recent interest in increasing the numbers of women in these fields. Whether or not there are innate sex differences related to differential achievements in mathematics and science is not clear. What is clear is that many gifted girls who appear to have the necessary aptitude for the study of higher mathematics self-select themselves out of mathematics courses in high school and college (Haven, 1973; Ernest, 1975; Sells, 1976). We cannot expect to increase the numbers of women in scientific career areas unless we first increase the participation of girls in advanced mathematics courses in high school. The most promising target population would be girls with well above-average ability in mathematics.

Several studies have attempted to determine factors that influence course-taking in mathematics by gifted girls. Three factors seem to be influential. First, career interests and aspirations are important. Girls who see mathematics as relevant to future career goals are more likely to take the courses than girls of similar ability but different career aspirations (Haven, 1973). Differential perceptions of the career relevance of mathematics for girls and boys occurs as early as grade seven (Hilton & Berglund, 1971). Second, encouragement from significant others, particularly fathers and teachers, has been found to be important in the development of women mathematicians (Helson, 1973; Luchins, 1976). On the other hand, misguided guidance counselors sometimes discourage gifted girls from taking advanced courses (Casserly, 1976).

Third, early "tracking" into accelerated or at least "gifted" programs encourage girls to take courses such as advanced placement calculus or physics (Casserley, 1975).

Studies of gifted adolescents, particularly mathematically gifted ones at The Johns Hopkins University have found the following to be true. First, in grades seven and eight there are more boys than girls who can be described as mathematically precocious (Stanley, 1973; Keating, 1974; Fox, 1976 a). Second, girls who are mathematically gifted are less eager than the boys to accelerate their educational progress in mathematics. Girls are also more likely than boys to perceive their parents as unfavorable towards such acceleration (Fox, 1975). Informal observations in counseling situations supports their view. Gifted girls also seem to fear peer rejection for becoming accelerated in mathematics. Boys do not express this concern. The study reported today by Solano indicates that the girls may be correct in their assessment of the situation. Third, attempts to foster acceleration in mathematics by means of grade-skipping, accelerated mathematics classes, and college courses have been considerably more successful for boys than girls. Fourth, values and career interest appear to be related to mathematical precocity (Fox, and Denham, 1974; Fox, 1976 b). This last finding will be discussed in greater detail by the next speaker.

A question of interest to this investigator was how to foster greater achievement of gifted girls in mathematics (as measured by advanced course taking in high school). This paper reports an attempt to influence later mathematics course-taking behavior of gifted girls by changing their course-taking behavior in the eighth grade. It seemed wisest to try to influence the behavior directly. Attitudes and career interests were given only secondary consideration. The attitudes of parents and teachers were only indirectly targeted.

An Intervention Program for Gifted Girls

In the spring of 1973, an experimental mathematics program for gifted seventh-grade girls was developed at The Johns Hopkins University. The goal of the program was to lessen the gap in later mathematics achievement (particularly differential course-taking) by providing an opportunity for acceleration in mathematics in the junior high school years. It was hoped that this moderate acceleration by one year would increase the likelihood of the girls' taking advanced mathematics courses in high school, and perhaps heighten their interest in mathematics and mathematical career areas.

The course began in May and continued through July. Classes met two days a week for about two hours. A standard Algebra I text was used.

Previous experiences with accelerated mathematics classes in the summer for both boys and girls had shown that attention to the social interests of girls was necessary. Thus, the class was designed to provide some social stimulation in several ways. First, it was for girls only. Second, the teacher was a woman and assisted by two female undergraduate mathematics majors who were to serve as role-models. Third, the structure of the class was informal. The class was organized for small group and individualized instruction. Cooperative rather than competitive activities were stressed. Fourth, whenever possible, the teachers emphasized the ways in which mathematics could be used to solve social problems. Traditional word problems were rewritten to be more socially appealing. In addition to the classes, there was a series of speakers, both men and women, who met with the girls to talk about careers in mathematics and science.

Several of the students expressed doubts about their abilities in mathematics. Some reported that their regular school mathematics teacher also expressed serious doubts about their abilities. A few parents also expressed concerns. It became necessary to continually encourage the girls to view themselves as competent in mathematics. Thus, individual and family counseling became an integral part of the program. A more detailed discussion of the course is reported elsewhere (Fox, 1976 a).

Selection of the Experimental Group

Students were selected for the program on the basis of performance on the Mathematics Subtest of the Scholastic Aptitude Test (SAT-M) in either the Mathematics or Verbal Contests conducted by the Study of Mathematically Precocious Youth (SMPY) and the Study of Verbally Gifted Youth (SVGY) at The Johns Hopkins University in the winter of 1973, and geographic considerations. Thirty-two seventh grade girls who lived in the Greater Baltimore area and who had scored at least 370 on the SAT-M in the contest were invited to the class. Two additional girls were also invited on the basis of referral and subsequent testing. Twenty-six girls enrolled for the course. Thus, three quarters of the girls invited enrolled. This was considerably better than the enrollment rates of 58 percent and 26 percent, respectively, for the two mixed-sex accelerated summer classes conducted by SMPY. Thus, the emphasis on social factors was successful in recruiting girls for such an accelerated program.

Selection of the Control Groups

Two control groups were formed. One of girls and one of boys. For each experimental girl who enrolled in the course, a control boy and a

control girl were selected from among the other seventh-grade participants in the 1973 contests. The control students were matched with the experimental subjects on the basis of scores on the mathematical and verbal subtests of the SAT, education of mother and education and occupation of father.

Although the matching was not perfect, the general pattern was to match within plus or minus 20 points on the SAT-M and SAT-V while controlling for educational and occupational level of parents. The mean scores on the SAT-M and SAT-V for the experimental girls were 436 and 399, respectively. The mean scores for the control girls on SAT-M and SAT-V were 433 and 390, respectively. For the control boys, the scores were 443 and 393, respectively. The details for the matching variables for the three groups are reported elsewhere (Fox, 1976 a) and are summarized in Table 1.

Insert Table 1

Pre-test

Prior to the course, the experimental and control groups were tested on knowledge of algebra, values and career interests. There were no significant differences between the three groups on knowledge of algebra. Control boys did differ significantly from the experimental and control girls with respect to values and one measure of career interests. The control boys were more interested in investigative career interests which include mathematical and scientific careers and scored significantly higher on the theoretical scale of the Allport-Vernon Lindzey Study of Values. Thus, at

the start of the program, the boys and girls were not very different with respect to achievement and aptitude in mathematics, but the boys were already slightly more pre-disposed towards the pursuit of mathematics in school and careers.

Hypotheses

The two major hypotheses of this study are as follows: First, gifted boys and girls of about equal ability in mathematics at grade seven and similar home backgrounds will differ in the high school years with respect to mathematics achievement as measured by the taking of advanced courses. This difference will be a result of differential interests and encouragement. Second, girls who receive special encouragement and facilitation in mathematics vis a vis an accelerated Algebra program will keep pace with or surpass their male and female cohorts with respect to achievement as measured by course work.

It is thus the premise of this paper that some type of intervention program in mathematics is necessary for gifted girls to insure their persistence and success at the same rate as that of their male counterparts. Gifted girls need more encouragement than gifted boys to pursue mathematics courses because there exist both internal and external barriers to the achievement of girls in mathematics.

Assessing the Intervention Program

The full impact of the intervention program for girls cannot be fully assessed until 1983, the year that these students would be expected to complete a four year bachelor's program. It is possible in the interim, however, to assess some educational progress during the three years following

the intervention program. We can determine some differences in course taking among the three groups in the junior and senior high school years. Changes in career interests can also be analyzed.

The 1974 Follow-up

The mathematics course for the experimental girls was not totally successful. Of the 26 girls who actually enrolled for the course, only 18 actually attended the classes on a fairly regular basis and completed the course. (The completion rate for the course was not significantly higher than the completion ratio for girls in two other accelerated classes which were co-educational and taught by a male). Of the 18 girls who completed the course only 11 actually enrolled for Algebra II the following year as eighth graders. This was a result of several factors, mainly the reluctance of schools to allow the girls to accelerate. Ten girls successfully completed Algebra II and were one year accelerated in mathematics at the end of 1974. None of the control boys and girls were accelerated at this time. A test of knowledge of Algebra given during the middle of the year showed the experimental girls to be significantly more advanced than the control girls and boys. There were no significant differences between the control girls and boys (Fox, 1976).

The 1976 Follow-up

In 1976, the experimental and control groups were canvassed by mail and phone as to their educational progress. Twenty-five of the experimental girls, 23 of the control girls and all of the control boys (26) were contacted. At this time all had completed the tenth grade. Of those responding 52% (13) of the experimental girls were accelerated in mathematics by at least one-half years and 48% (12) were accelerated by one or more years.

Only 17 percent of the control girls were accelerated by one-half year. This was significantly different from the experimental girls (Chi Square = 6.27, $p < .02$). Only nine percent of the control girls were accelerated by one year or more (Chi Square = 8.96, $p < .01$). Thus the experimental girls were considerably more accelerated than the control girls. Data are shown in Table 2.

Insert Table 2

The control boys were accelerated, however, at about the same rate as the experimental girls, but significantly more than the control girls. Fifty percent of the control boys were accelerated by one-half year in mathematics and 31 percent were one or more years accelerated.

The actual courses taken are shown in Table 3. Twelve of the

Insert Table 3

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experimental girls but only two control girls and eight control boys had completed all of the courses that typically precede calculus. Thus it does appear that course taking behavior of gifted girls can be modified. Career interest, however, seem more difficult to influence.

Career Interests

In 1973, prior to the start of the special class, all three groups were tested on two measures of vocational interest. On an abbreviated form of the Vocational Preference Inventory (VPI), the boys were significantly more interested in investigative careers than were either group of girls. On a questionnaire item, however, there were no significant differences among the three groups with respect to stated career preference in a mathematical

or scientific area (Fox, 1974).

In 1974, 1975, and 1976 students in all three groups were asked their career preference. Data are shown in Table 4.

Insert Table 4

In 1974 and 1975 the experimental girls who had accelerated were more interested in scientific or mathematical careers than the control girls or the non-accelerated experimental girls. By the end of 1976 the accelerated experimental girls were no longer ahead of the control girls and there were no significant differences among the three groups.

All three groups expressed more interest in mathematical and/or scientific career areas by the end of 1976 as compared with 1973. It does not seem that the experimental treatment can be said to have made a difference. There is one interesting trend. The greatest shift toward interest in these career areas occurred for accelerated experimental and control girls at the end of the respective years in which they became accelerated in mathematics. This was not true for the boys.

Preliminary Conclusions

In the absence of special intervention efforts for girls, it appears that boys and girls with similar mathematical and verbal aptitudes and family backgrounds differ significantly with respect to course taking behavior in mathematics by the end of the tenth grade. Course taking behavior of gifted girls, however, was modified by early intervention. The experimental girls have kept pace with the boys. Thus, at present, the two hypotheses of the study are supported.

The long range question of great importance is will the experimental girls continue to keep pace with the boys and will the experimental girls and control boys continue to stay ahead of the control girls? If the study is continued the results may change. Alas, the mathematics course-taking planned by the students for the next two years is not encouraging. Of the twelve experimental girls who have completed the pre-calculus sequence only six plan to take calculus this year. Five will take College Algebra and one will take no mathematics at all. Fifteen of the experimental girls (60 percent) do plan to take calculus before completing high school. Three of the control girls will take calculus this year and eleven (48 percent) plan to take calculus in high school. Although only eight of the control boys completed the pre-calculus sequence in the tenth grade, eleven boys expect to take calculus next year. Eighteen boys (70 percent) plan to complete calculus in high school. Thus the gains from the experimental treatment may begin to fade over time in the absence of additional special encouragement and in the presence of probable traditional discouragement.

There are at least two valid criticisms of this study. First, the selection of the girls for the special class was based on cognitive factors and not interests and values. The results indicate that the treatment might have been more potent for girls already interested in mathematical careers. Second, it might have been better to have manipulated fewer dimensions in the treatment. If the treatment is successful, it will be difficult to say which elements are most important. For example, how important is the all-girl nature of the class? Under Title IX same sex classes will be difficult to arrange in most situations.

In response to these criticisms, I would like to say that my goal was to try to produce a significant change in behavior, and I felt justified in

manipulating as much as possible. Subsequent work with other gifted students in special accelerated classes in school settings seems to indicate that the all-girl nature of the class is not essential. Nor does sex of the teacher seem as important as the attitudes of the teacher.

What is needed are large scale longitudinal research projects that uses similar selection and evaluation procedures but manipulate different variables and combinations of variables. Also I think it is important to note that not all of the gifted boys plan to take calculus in the high school. We should not overlook boys in our attempts to understand and control factors which influence the development of mathematical competence among the gifted. Although mathematics course-taking may not be the most crucial educational need of the gifted child, it is a powerful determiner of later educational career and educational opportunities and should be studied.

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Tables for

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Table 1: Summary of Selected Variables

	No.	Mean SAT-M	Mean SAT-V	Mean Educational Level* Mother	Father
Experimental Girls	26	436	399	2.9	3.3
Control Girls	26	433	390	2.9	3.7
Control Boys	26	443	393	2.7	3.5

* Scale for educational level

1 = less than high school

2 = high school diploma

3 = some college

4 = Bachelor's degree

5 = more than Bachelor's degree

Table 2: Number and Percent of Students in Three Groups, by Degree of Acceleration in Mathematics at the End of the Tenth Grade

	Number Responding	Degree of Accelration 1/2 year or more #	%	1 year or more #	%
Experimental Girls	25	13	52	12	48
Control Girls	23	4	17	2	9
Control Boys	26	13	50	8	31

Table 3: Courses Completed at the End of Tenth Grade

	Alg.I&II	Alg.I & Pl.Geom.	Alg.I&II Pl.Geom.	Alg.I&II Pl.Geom. Solid G.	Alg.I&II Pl.Geom. Trig.	Alg.I&II Pl.Geom. Trig. Analyt.G.	Alg.I&II Pl.Geom. Trig. Analyt.G. Coll.Alg.	Alg.I&II Pl.Geom. Elementary Functions &Analyt.G.	Alg.I&II Pl.Geom. Trig. Probability Modern Alg.
Experimental Girls	1	1	10		1	8	3	1	
Control Girls	3	2	14	1	1	1		1	
Control Boys	3	1	9		5	5	2		1

Total number of experimental girls responding = 25

Total number of control girls responding = 23

Total number of control boys responding = 26

Table 4 : Vocational Interests of Those Currently Accelerated and Non-Accelerated

	1973 pre-test				1974 post-test				1975 follow-up				1976 follow-up			
	# Responses	# Sci./Math	# Non-Sci.	% Sci./Math	# Responses	# Sci./Math	# Non-Sci.	% Sci./Math	# Responses	# Sci./Math	# Non-Sci.	% Sci./Math	# Responses	# Sci./Math	# Non-Sci.	% Sci./Math
Accelerated experimental girls	13	7	6	54%	13	10	3	77%	11	9	2	82%	12	8	4	67%
Non-accelerated experimental girls	13	3	10	23%	11	4	7	36%	10	4	6	40%	11	4	7	36%
Accelerated control girls	4	1	3	25%	4	1	3	25%	4	1	3	25%	4	3	1	75%
Non-accelerated control girls	21	7	14	33%	20	8	12	40%	21	9	12	43%	19	11	8	58%
Accelerated control boys	13	7	6	54%	10	7	3	70%	10	7	3	70%	12	9	3	75%
Non-accelerated control boys	12	8	4	67%	11	7	4	64%	11	8	3	73%	11	8	3	73%